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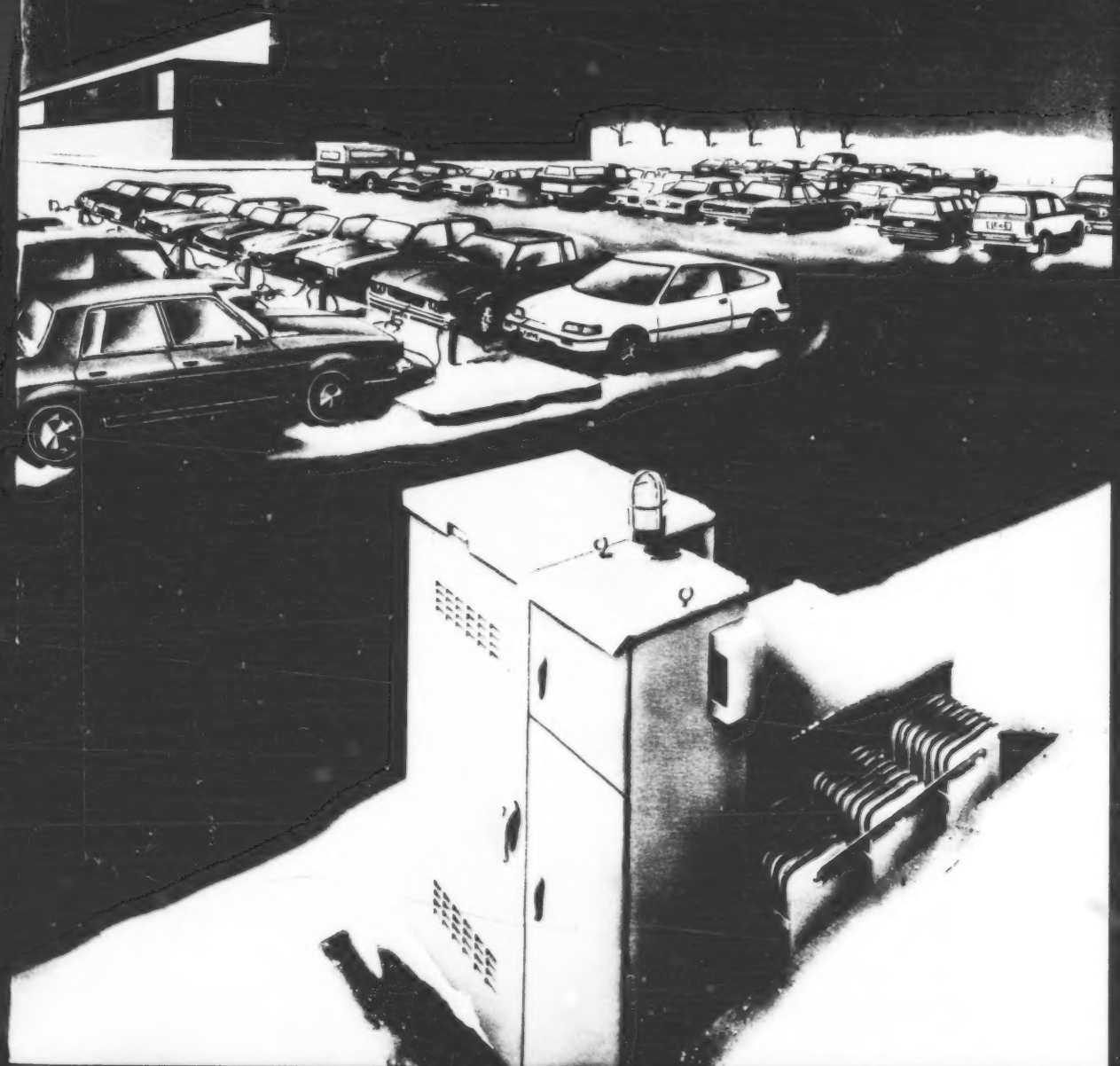

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Cover Illustratinn: A programmable controller (foreground) is used at The University of Lethbridge to control the supply of electricity to the electrical outlets in the adjacent parking lot. While this allows automobile block heaters to operate long enough to keep engines warm, the intermittent supply of power allows the university to save on energy costs.

A Programmable Controller for Parking Lot Block Heaters

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Disclaimer

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Foreword

Since 1976, numerous projects have been initiated in Alberta by industry and by academic research institutions which are aimed at better utilization of Alberta's energy resources.

These research, development and demonstration efforts were funded by the Alberta/Canada Energy Resources Research Fund (A/CERRF), which was established as a result of the 1974 agreement on oil prices between the federal government and the producing provinces.

Responsibility for applying and administering the fund rests with the A/CERRF Committee, made up of senior Alberta and federal government officials.

A/CERRF program priorities have focused on coal, energy conservation and renewable energy and conventional energy resources. Administration for the program is provided by staff within the Scientific and Engineering Services and Research Division of Alberta Energy.

In order to make research results available to industry and others who can use the information, highlights of studies are reported in a series of technology transfer booklets. For more information about other publications in the series, please refer to page nine.

A Programmable Controller for Parking Lot Block Heaters

Automobile block heaters and interior car warmers are used by a substantially larger percentage of Alberta motorists (95 per cent and 54 per cent, respectively) than in the rest of Canada where, on average, only 27 per cent of all drivers use plug-in block heaters and eight per cent use interior warmers. This represents a substantial wintertime demand for electricity in Alberta, usually at a time when the daily demand for electricity reaches its peak.

Therefore, any method of reducing the need for block heaters and vehicle warmers can save energy and help lower the peak demand for electricity in the evening.

While "power-saver" electrical cords can be installed in individual automobiles to switch on the power to block heaters after the engine temperature has fallen to a certain level, and timers have been used in some parking lots to interrupt the power supplied to outdoor plugs, neither of these measures represents the optimum system that might be used in large parking lots.

One system that does show considerable promise, however, controls both time and temperature in a scheme demonstrated by MAGNA IV Engineering Ltd. of Edmonton and financed in part by A/CERRF.

Background

Beginning in the early 1970s, several studies showed that plugging in an automobile's block heater for a maximum of three hours, regardless of the outside temperature, is sufficient to allow the engine to be readily started; an engine kept at -7°C (20°F) will start easily.

It was also found that for a given power output, block heaters will raise an engine's temperature by the same amount regardless of how low the initial temperature. However, the lower the temperature the longer the block heater must operate to maintain the engine coolant at -7°C.

Control Strategy

In 1985, MAGNA IV designed a control strategy for the parking lot at The University of Lethbridge, assuming the following criteria:

- 200 parking stalls are used on average during maximum-usage periods, while 100 stalls are used during minimum-usage periods;
- maximum-usage periods last 12 hours, from 7:00 a.m. to 7:00 p.m., while minimum-usage periods are from 7:00 p.m. to 7:00 a.m.;
- outside plug-in circuits are used 25 days a month, from mid-November to mid-March;
- every car that uses the parking lot is equipped with a 600 W block heater, and half the cars use 400 W interior heaters;
- the average electrical load per vehicle is 800 W;
- the average energy charge is $0.04/kWh and the average demand charge is $3.25/kW/month; and
- an average vehicle coolant temperature of -7°C is to be maintained.

Two control schemes were proposed, each of which was designed to supply power to the plug-in circuits for different periods of time according to the ambient temperature. This was followed by intervals without power, as follows:

	Temperature	Time	Cycling Pattern
System #1			
	Above 0°C (32°F)	00:00-24:00	Power off
	0°C to -15°C (32°F to 5°F)	07:00-18:59	20 minutes power on 40 minutes power off
		19:00-06:59	10 minutes power on 50 minutes power off
	Below -15°C (5°F)	07:00-18:59	30 minutes power on 30 minutes power off
		19:00-06:59	20 minutes power on 40 minutes power off

	Temperature	Time	Cycling Pattern
System #2			
	Above 0°C (32°F)	00:00-24:00	Power off
	0°C to -15°C (32°F to 5°F)	07:00-18:59	20 minutes power on 40 minutes power off
		19:00-06:59	10 minutes power on 50 minutes power off
	Below -15°C (5°F)	07:00-09:59	30 minutes power on 30 minutes power off
		10:00-11:59	40 minutes power on 20 minutes power off
		12:00-15:59	30 minutes power on 30 minutes power off
		16:00-17:59	40 minutes power on 20 minutes power off
		18:00-18:59	30 minutes power on 30 minutes power off
		19:00-06:59	20 minutes power on 40 minutes power off

The estimated power consumption for each of these control schemes and the associated energy costs were then compared with normal, uncontrolled operation of the plug-in circuits, which allowed power to be supplied continuously from mid-November to mid-March. The comparisons assumed that some demand cost savings were possible.

System	Maximum kW Demand	kWh	Total Energy Cost ($)	Difference ($)
Uncontrolled	160	288 000	17 760	–
System #1	80	104 000	7 280	10 480
System #2	160	109 334	10 613	7 147

It was estimated that it would cost $14 000 to build a programmable controller capable of supplying power according to either control scheme, and a simple payback period of 1.3 years was projected for System #1.

Controller Installations and Operation

A stand-alone, programmable controller was used and programmed to provide controlled switching of power to 36 120 volt A.C. circuits that serviced 12 rows of parking stalls (approximately 400 parking spaces) at The University of Lethbridge parking lot.

To achieve maximum flexibility in the operation of the controller, each of 12 power circuits was individually switched by its own dedicated contactor, which was controlled as a separate output on the programmable controller. This was achieved through the programmable features of the controller, and allowed the circuits to be switched on or off individually or in groups.

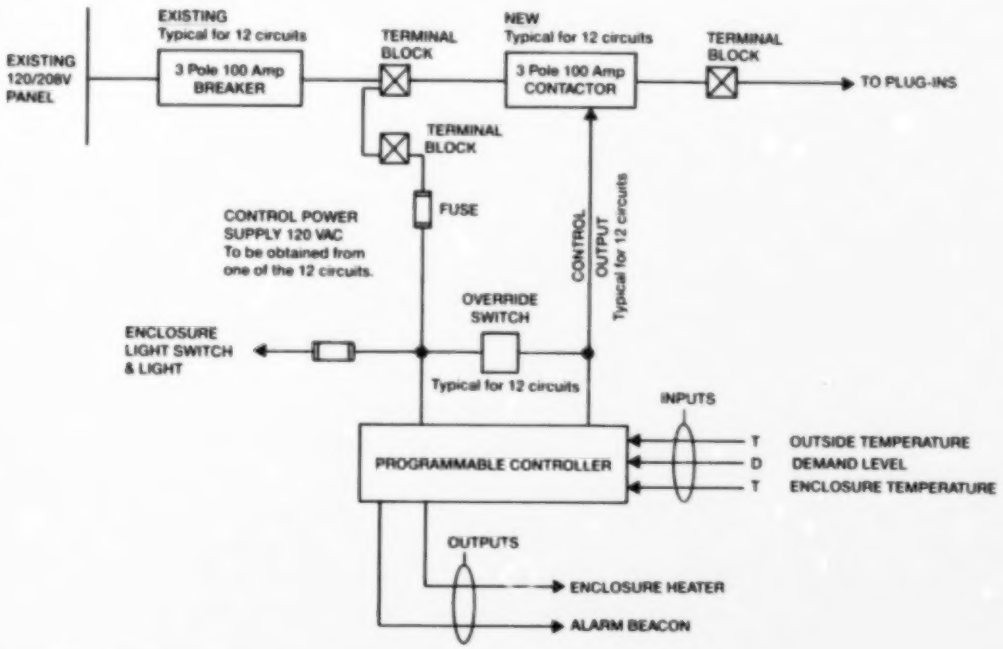
The individual switching arrangement makes it possible to reduce the peak demand for electricity, which can have a substantial effect on cost savings.

For one week before the controller began operating, some baseline information, such as the number of cars in the parking lot and the number that were using plug-ins, was obtained six times a day. Also, the ambient temperature and electricity consumption were recorded. These measurements were repeated over a one-week period after the System #1 control scheme was initiated.

From a comparison of results before and after the programmable controller began operating, it was observed that substantially less energy was being used during the System #1 operating period. It was also learned that most of the cars used block heaters that were smaller than those assumed in the original cost analysis. This meant the average electrical load for each vehicle was approximately 500 W, rather than 800 W.

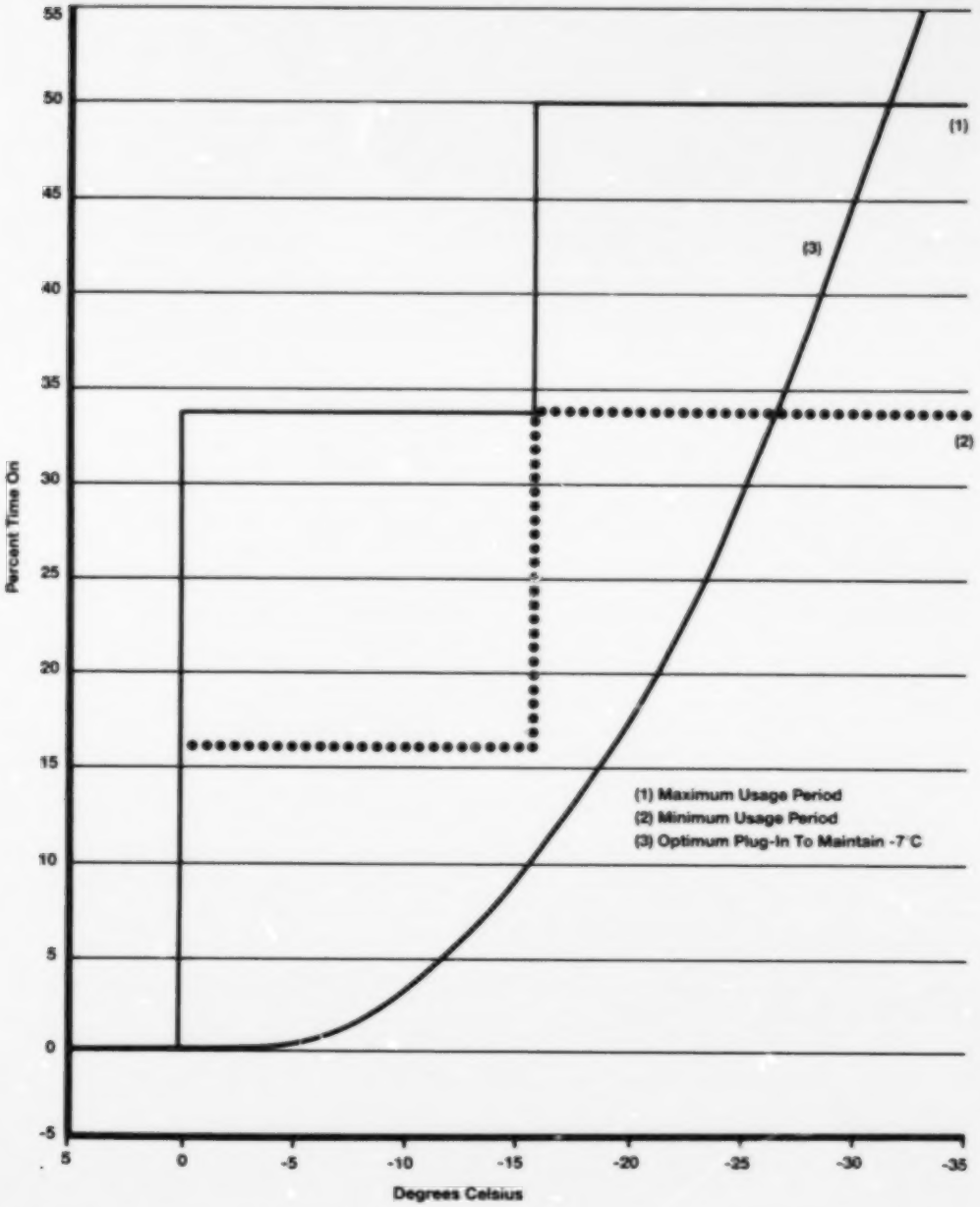
A survey of parking lot users revealed that some were unhappy with the length of the over-night "power off" period, leading to a revision of this portion of the control sequence. In its revised form, the night-time segment began at 10:00 p.m. and ended at 5:00 a.m.

Typical Control Block Diagram



Source: *Programmable Controller for Parking Lot Block Heater Services*, MAGNA IV Engineering Ltd., November 1986.

Graphical Representation of System #1 Control Scheme



(Source: *Programmable Controller for Parking Lot Block Heater Services*, MAGNA IV Engineering Ltd. November 1986)

Electricity Consumption for February 18*, 1986

Number of Cars Plugged In	Instantaneous kW	Calculated W/Car Controlled	Uncontrolled
280	80.1	286	572
302	80.4	266	532
242	73.1	302	604

*average temperature: -25°C (-13°F)

It was noted that the peak energy consumption was successfully controlled by the programmable controller, and the maximum peak energy demand while the controller was operating was one-half the maximum during uncontrolled periods.

Assuming it is possible to reduce energy demand costs, it was calculated from these revised data that The University of Lethbridge could save approximately $7 000 a year by operating the programmable controller. This amounts to a payback period of two years for System #1.

System	Maximum kW Demand	kWh	Total Cost ($)	Difference ($)
Uncontrolled	100	205 000	12 100	–
System #1	50	79 583	5 133	6 967
System #2	100	82 917	7 217	4 883

If, however, energy demand costs are not changed, the following estimates apply:

System	kWh	Cost ($)	Difference ($)
Uncontrolled	205 000	8 200	–
System #1	79 583	3 183	5 017
System #2	82 917	3 317	4 883

Under these conditions, the payback period for System #1 would be approximately 2.8 years.

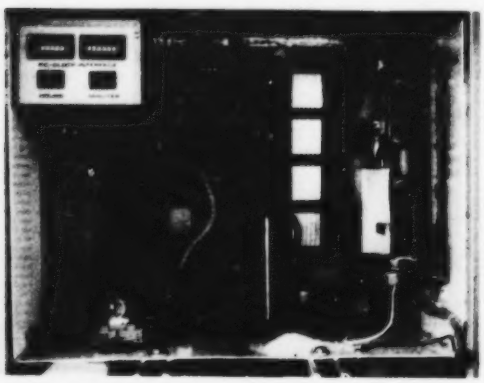
Conclusions

Parking lot users did not report any inconvenience or discomfort after the on-off sequencing was altered. It was concluded that this fact, combined with the potential energy and cost savings, made the system widely applicable throughout Alberta. A two-year payback period makes this concept particularly attractive; even in those situations where energy demand costs cannot be lowered, a 2.8-year payback period is still impressive.

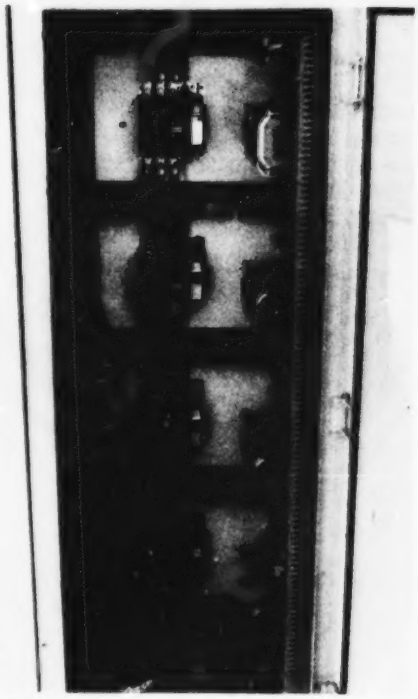
To apply the system to other parking lot situations, the following information must be obtained:

- typical winter temperatures and duration;
- the number of parking stalls;
- a profile of parking lot usage; and
- electricity rates.

Based on The University of Lethbridge experience, per unit energy cost savings of $36.80, and demand cost savings of $15.60, were calculated for a total of $52.40 for each power receptacle in use.



Controller detail.



Controller detail.

(Photos courtesy of The University of Lethbridge, Printing Services)

Contact

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